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ABSTRACT

Experiments reported in this document were intended to shed light on the linguistic and presentational issues surrounding the provision of a subtitling service for deaf schoolchildren. A series of formal experiments was carried out to evaluate deaf children's appreciation of subtitled television programs. (These experiments are described in detail in Appendix II.) Issues explored were the optimum presentation rate for subtitles, and the measurement of program content comprehension using multiple-choice questionnaires. The findings show that subtitles can and do make program content accessible to deaf children, provided they are presented at a manageable reading rate. Reduction to a suitable reading rate is an efficient and effective strategy for simplifying the language level. The studies also show that teachers of the deaf are in a privileged position to carry out suitable subtitle editing. A project designed to meet the demand for school subtitling facilities is currently in progress at the University of Southampton. This six-section report includes discussions of: (1) background; (2) reading; (3) television and children; (4) published guidelines for modifying English for deaf children; (5) summary of experimental research carried out in schools for deaf children; and (6) conclusions, recommendations for broadcasters, and key issues for the future. The report concludes with a three-page bibliography and four appendices that include experiment details, samples of language simplification, and subtitle editing strategies. (THC)

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SUBTITLING TELEVISION FOR DEAF CHILDREN

M.E.R.: No. 3

Robert Baker

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Editorial Note

This publication is the third in a series of working papers concerned with the study and use of media in education. The work described in this paper was carried out while the author was engaged in a research project supported by the Independent Broadcasting Authority and ORACLE Teletext Limited. The author worked from late 1978 until 1983 on projects sponsored by Independent Television and aimed at the development of television subtitling techniques and equipment for use with ITV ORACLE's teletext system. The bulk of this research was directed towards the needs of a mass adult hearing-impaired television viewership, estimated at upwards of two and a half million people. Deaf children form a much smaller target group, who nevertheless stand to gain a great deal from being given access to educational television.

The experiments reported here were intended to throw some light on the linguistic and presentational issues surrounding the provision of a subtitling service for deaf schoolchildren. As such it is hoped that the results will be of interest to teachers, educational technologists and broadcasters.

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Author's Note

I would like to express my thanks to the sponsoring organisations for financial and moral support throughout the project, and for permission to publish this report. In addition I would like to thank the pupils and staff of:-

Nutfield Priory School for the Deaf, Redhill
The Royal School for the Deaf, Margate
Heathlands School, St Albans
Centre for the Deaf, The City Lit., London

This paper is dedicated to Erinaceus Europaeus.

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Subtitling Television for Deaf Children

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1. Background

1.1 Teletext subtitling for an adult hearing-impaired viewership - a research programme

The first IBA/ITCA subtitling project was funded at Southampton University between 1978 and 1981 and was established to provide broadcasters with comprehensive operational guidelines for a teletext subtitling service for hearing-impaired viewers. Aspects of linguistic style, of editorial policy and of subtitle display, as constrained by the 1976 teletext specification, were investigated along with preliminary studies of subtitle preparation routines for both live and off-line subtitling and an evaluation of available hardware and software.

The initial approach taken in the work was to survey the existing knowledge about subtitling techniques. In 1978 there were two main potential sources of information. These were:-

a) BBC2 "News Review"

b) Foreign Language films

"News Review" was not considered to be an appropriate source of guidance due to its unrepresentativeness as a television programme. As a news programme it is unique in that i) it is not transmitted live; both programme and subtitles are planned and recorded well in advance, and ii) the programme is produced with subtitling in mind, and it is presented by the clearest speakers among newscasters, speaking at a somewhat slower rate than usual. The many factors which militate against effective subtitling in the majority of programmes - rapid shot changes, speech off-camera, the hectic pace of normal conversational television speech etc. - are absent from "News Review".

The British Film Institute was contacted for information about codes of practice for subtitling foreign language films. The reply received was that no such thing existed and that films were subtitled on an 'ad hoc' basis by freelancers. This may go some way to explain the variable quality shown in the subtitling of foreign movies. Even if general guidelines had been available they would have been of limited use for the principal reason that foreign language films are subtitled with normally hearing viewers in mind. Thus it is assumed that the viewer can distinguish between different voices (even if speakers are off-screen) and between different tones of voice. Sound effects and incidental music, which may be critical to the interpretation of the plot, are also assumed to be available to the viewer. One possibly useful generalization to be drawn from monitoring a large number of such films is that no matter what the source language of the film, the quantity of dialogue is reduced by as much as one third during the translation process, presumably in order to allow additional reading time at the expense of linguistic redundancy. The translation process itself is of course a further dimension which is absent when subtitling native language programmes for hearing impaired viewers.

Given these various limitations it was decided to start the research from scratch, attempting to set aside all preconceptions about the nature of subtitling and to focus attention on a range of relatively independent subtitling problems such as screen

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position, text presentation rate, etc. Videotapes embodying alternative approaches to such problems were produced and shown to hearing-impaired audiences (perhaps 'viewerships' would be a preferable term).

In order to sample a fairly representative viewership the experimental trials were centred on social clubs for the deaf and hard of hearing. In this way a large number of viewers from a wide age and social class range could be canvassed. Each subtitling technique was shown at at least one 'deaf club' and one 'hard of hearing club', to ensure that the responses of both prelingually deaf and postlingually deaf people were elicited. Responses were gauged by questionnaires and open discussion. The aim of the experiments was to establish a consensus about techniques which would satisfy as many viewers as possible while avoiding techniques to which a minority of viewers have strong objections. The results of nearly 3 years of such experiments are incorporated into two booklets (Baker, 1981; Baker, Lambourne and Rowston, 1982).

1.2 Limitations of early research with adult viewers

The mainstream research strategy failed to provide comprehensive recommendations in two main areas. The first of these, real-time subtitling of live TV programmes, posed a fundamental problem of technical development as well as audience reaction. This topic is dealt with elsewhere (Lambourne et al, 1984). The second residual problem area concerns a limitation on the validity of the results obtained in the deaf clubs. In the majority of deaf clubs (predominantly for prelingually deaf people), as opposed to the hard of hearing clubs (predominantly for postlingually deaf people), a proportion of club members chose not to take part in the subtitling experiments. This proportion ranged from 10% - 30%of people attending the clubs. It is well known that people with early deafness are disadvantaged in the acquisition of literacy skills, and it can be safely assumed that roughly the stated proportion of prelingually deaf people do not have sufficient confidence in their own reading ability to find the prospect of watching and commenting on a subtitled programme particularly attractive. This group of people had therefore effectively selected themselves out of our investigations.

Several possible solutions to the problem of inadequate reading skills have been considered. First of all it should be noted that only a very small proportion of the total hearing-impaired viewership is involved. Not more than 2% of all hearing-impaired people have suffered early childhood hearing loss with its associated educational setbacks. 10% - 30% of these represents roughly 5,000 to 15,000 individuals in the UK. Nevertheless, this group of people is perhaps the most severely afflicted in terms of information deprivation, and therefore in principle stands to gain most of all from television programmes suited to their communication needs.

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Four fundamentally different approaches to providing suitable access to television can be considered. Firstly, programmes could be provided with a sign language commentary rather than subtitles, since the majority of the less able deaf readers are fully conversant with British Sign language. The primary objection to this approach is technical. It is as yet not possible to present sign language commentary as an optional extra in the same way that teletext subtitles are offered. Thus it would lead to strong objections not only from the general hearing public but most significantly from the vast majority of postlingually deaf viewers who have no competence in sign language and who are trying to concentrate their attention on the subtitles.

Secondly, a highly simplified form of subtitling might be envisaged in which the lowest common denominator of literacy skills forms the linguistic basis. There are two problems here. Firstly, simplified subtitles are rejected as insulting and patronizing by the overwhelming majority of hearing-impaired viewers. Secondly, difficulties would be encountered in establishing what lowest common denominator would be appropriate. Some deaf people, just like some hearing people, are totally illiterate - and the logical match for no reading ability would be no subtitles.

A more sophisticated technical compromise is in fact offered by the teletext specification. By fully exploiting the system it is possible to offer more than one language level for subtitles on a single programme. By storing subtitles on different teletext pages (or even in different parts of a single page - see Baker and Lambourne, 1982) broadcasters could provide, for example, a set of heavily simplified subtitles and an alternative set of more comprehensive subtitles as viewer options. It is hoped that over-air trials of this technique will be forthcoming in the near future. However, it seems unlikely that the practice of subtitling programmes at two levels will become widespread until at least the majority of programmes are subtitled at one standard level.

The real long-term solution to the problem of deaf literacy levels is, of course, education. There is no organic reason for the low level of literacy attainment characteristic of prelingually deaf children. The educational difficulty is, however, twofold. Firstly, the deaf child is cut off from one of the main sources of associative learning about the mechanics of reading which is available to the hearing child, especially in languages with an alphabetic (or quasi-alphabetic) writing system like English, i.e. the reciprocal link between strings of sounds and strings of characters. Secondly, the deaf child typically receives a grossly restricted linguistic input of whatever nature. Success in lipreading virtually relies on the existence in the child of a fully developed linguistic data base or internal grammar, which in turn must somehow be built up from a severely degraded or non-existent auditory input. Thus the syntactic infrastructure for language develops only with great difficulty. The resulting communication block means that the child is effectively deprived of huge quantities of cultural background - the basis for further linguistic development. The circle is vicious.

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1.3 Subtitling and literacy

It is likely that changes in educational practice can alleviate the general linguistic retardation. In particular a relaxing of attitudes towards sign language could make available a visual language system inherently learnable by deaf children which may form the necessary linguistic basis for conceptual and cultural development (Conrad, 1979). If a knowledge of sign language can be presupposed, then the teaching of English, both spoken and written, can be approached in much the same way as it is in other bilingual communities (Llewelyn-Jones, 1983). Even after such changes in educational policy have been adopted, there will remain a need for English language materials in a medium accessible to deaf children. One such medium is TV subtitling.

The extent to which subtitles themselves can contribute, both now and in future, to the improvement of linguistic skills among deaf children is a natural question to have grown out of the mainstream project. Informal comments received from parents and teachers in recent years suggest that even the "adult" level of subtitling currently offered by Ceefax and ORACLE has had a beneficial effect on their children's motivation and ability to read. Subtitled television of course provides a potentially ideal situation for presenting words and pictures linked together in a dynamic, meaningful and inherently attractive way. There is direct evidence of a positive effect on reading skills in a study published in the USA (Caldwell, 1973). Caldwell's investigation showed that even children who were given subtitles at a language level three grade levels ahead of their measured reading ability, demonstrated (over a 5 week period) significant gains in performance on a battery of reading and language tests. Subtitles were seen by Caldwell as "additional exercises in developmental reading and language fluency".

Closer to home, the work of Hill (1981), monitoring the reactions of deaf middle school children to a Yorkshire Television schools broadcasting series with subtitles, stressed the importance of selecting an appropriate language level for subtitles. Unless the language used is simple enough and presented at a slow enough pace for children to get a foothold on the meaning of a programme, the enterprise is lost. However, as Caldwell's work so clearly illustrates, this does not mean that the language used should present no challenge to the child.

As in the earlier research with adult hearing impaired viewers it was decided to survey the state of available knowledge relevant to subtitling television for deaf children.

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2. Reading

2.1 Reading ability of deaf schoolchildren

Conrad (1979) surveyed the reading abilities of all deaf children leaving school in England and Wales in the years 1974 to 1976. He discovered that these school leavers had a median reading age of 9 years, in other words half of them had a reading age of less than 9 years. It is important to put this statement in context. According to the Bullock report (Bullock, 1980) between 3 and 4 per cent of hearing children leave school with a reading age of less than 9 years and there are accordingly approximately 1 million adults in the UK possessing only such limited reading skills. A reading age of between 7 and 9 years is defined by Bullock as "semi-literacy", while a reading age of less than 7 years is considered to represent total illiteracy. In Conrad's study roughly 28% of deaf schoolleavers have a reading age of less than 7.

Definitions of functional literacy vary widely. A reading age of 13 is considered by Moyle (1973) to be necessary for reading the simplest daily newspaper. On the other hand reviews of children's literature (Lunzer and Gardner, 1979) suggest that quite young children will find a wide range of literature fairly accessible, if they are sufficiently motivated. However, it may be misleading to evaluate the reading skills of deaf children in terms of those of hearing children. It is necessary to look more closely at the nature of the reading process.

2.2 The nature of the reading process

Reading is generally accepted to be a form of "psycholinguistic guessing game" (Goodman, 1970) whereby the reader maps his/her knowledge of the language (and indeed of the world) on to the text, predicting and constructing sentences on the basis of a grammatical structure and semantic relationships which are shared by reader and writer. In this respect even the beginning reader is usually reading language with which he/she is by and large already familiar. The basic language development of a hearing child is practically complete by the age of 5 years. This is not true of the deaf child. The deaf child brings a very rudimentary experience of English to the reading task and accordingly has virtually nothing to map on to the text before him/her apart from a few crude and hazy notions about word order (Scholes et al., 1978) and a very restricted and poorly differentiated lexicon. Silverman-Dresner and Guilfoyle (1972) found that 8-9 year-old deaf Americans were able to choose correct definitions for only 18 words out of a list of 7,300 words commonly known to hearing children. By the age of 17 they could choose correct definitions for only about 1/3 of the words in the list. Walter (1978) found that the average 14 year-old deaf American only understands 60% of the 2,000 most common English words. For the deaf schoolchild reading is a primary source of English language experience, yet due to fundamental deficiencies in the infrastructure on which language develops, it is a slippery slope indeed.Let us examine the cycle of deprivation more closely.

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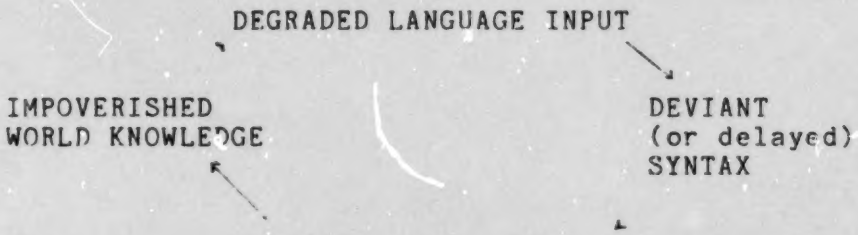
2.3 Linguistic retardation of deaf children



The initial problem, of course, is that the incoming language data are degraded through hearing loss. Even quite mild hearing loss can have a marked effect on language development (Bench and Bamford, 1979). The nature of the language deficit is widely regarded as syntactic. Ivimey (1977) demonstrates this by some examples designed to show that syntactic effects override purely perceptual problems. Thus the word "to" in the two sentences:-

"I went to London" and

"I gave the book to her"

is equally easy or difficult to perceive (through hearing or lipreading) in both cases. However they have quite distinct syntactic functions and deaf children tend to omit "to" in producing the second sentence but not the first. Quigley and his associates (Quigley & Kretschmer 1982) have charted the syntactic development of American deaf children. These researchers demonstrate that the order of acquisition of syntactic structures tends to follow that of hearing children but is severely delayed. Indeed, many deaf children achieve only a very simple and rigid grammar of the Subject-Verb-Object form, which is then superimposed on to all English language tasks. Thus deaf children frequently misinterpret passive sentences in which the Subject-Verb-Object order is reversed (Moores 1978). In an experiment conducted by the Southampton research team (Downton et al., 1983) groups of prelingually and postlingually deaf adults were asked to complete a "cloze" text, in which passages of text had words omitted at intervals and the subjects had to fill in the gaps;

e.g. "Many of our fine are becoming polluted with oil."

Responses may be both semantically and syntactically correct (i.e. "beaches" above, or indeed "resorts", though this was not the original word used in the passage). Secondly, they may be semantically appropriate but syntactically incorrect, e.g. "sand" or "beach". Thirdly, they may be syntactically correct but semantically inappropriate, e.g. "churches". Finally, responses may be inappropriate both semantically and syntactically, e.g. "who". In a comparison of the data from the two groups it was found that the errors made by postlingually deaf adults tended to be equally often semantically appropriate only or syntactically correct only. With the prelingually deaf group on the other hand there were significantly more errors which were semantically appropriate only (and syntactically incorrect) than vice versa (two-tailed Wilcoxon test $T=4$, 12 subjects $p < 0.01$).

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Gormley and Franzen (1978), however, argue strongly against placing too much emphasis on syntactic deficit in discussing the

reading problems of deaf children. Deaf children bring to bear whatever syntactic knowledge they have, be it from English or from sign language,* together with general knowledge of the world, in order to construct a coherent semantic interpretation of the text. Thus, the authors argue that reading texts for deaf learners should focus on highly familiar and predictable vocabulary. Emphasis in teaching should be on understanding the intended message of a text rather than disentangling its syntax.

Notwithstanding these valuable observations it must be stated that the teaching of effective English skills remains one of the principal aims in the education of deaf children. Most importantly, the acquisition of new vocabulary normally relies heavily on the use of words in context, and both syntactic and semantic context are used in the interpretation of new words. Accordingly, a restricted syntax will inhibit the development of vocabulary.

Finally on the vicious circle, the growth of world knowledge and general conceptual development are heavily reliant in our culture on words and meanings derived from reading, and vice-versa, so that reading deficiency itself contributes to the impoverishment of language data available to a child.

What can be done to improve this situation? It is argued by Conrad (1979), among many others, that the use of sign language in deaf education will break the circle at several points. Most obviously, offering a language code which deaf children acquire with ease and efficiency will provide a vehicle for learning about the world. Secondly sign language can provide the child with a working grammar of a natural language, thus opening up the conceptual basis of syntactic awareness - the language acquisition device upon which all human languages are founded (Chomsky, 1965). Knowing one language, it is easier to acquire others. More controversially, some form of manual language may be used directly in the teaching of English structure, either by modifying the sign language to approximate to English grammar, or by adopting a thoroughgoing bi-lingual teaching method (Llewelyn Jones, 1983).
At another level of analysis, there is clearly a need for more English language materials suited to the needs and abilities of deaf children, materials which begin where the child begins and offer the child opportunities for development from more familiar to less familiar modes of expression, thus weakening the vicious circle at all points. This holds true no matter what other teaching orthodoxy is adopted. The paucity of suitable materials is highlighted by La Sasso (1978). This author, in a survey of schools for the deaf in the USA found that in 78% of cases the main method of teaching reading was through standard beginning reading texts ("Janet and John" style) and that these texts were too difficult for the children concerned, not only on the admission of their teachers but also according to the syntactic guidelines of Quigley and Kretschmer (1982). La Sasso considered the development of appropriate reading material to be a "top research priority".

***Footnote:**

Odom and Blanton (1970) demonstrate that deaf students perform better on reading comprehension tests in which the source texts are transformed into a syntax more closely following the syntax of sign language.

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3. Television and Children

It is a truism that children like to watch television. The average US child watches 2-3 hours of TV per day. Few other activities could command such attention (Winick and Winick, 1979). In an interesting survey of the recreational activities of Swedish children Feilitzen (1976) puts this in context. Virtually all Swedish children between ages 3 - 15 watch television at least once a week. By comparison, exposure to books either by reading or by being read to, is more frequent at earlier ages, occurring at least once a week for 80% of children between the ages of 3 and 9, but then dropping rapidly to less than 45% by age 13-15. One quarter of 13-15 year olds say they never read books for pleasure. It is also interesting to compare radio listening, since this source of entertainment and information is not available to deaf children. In Sweden the number of children listening to the radio at least once a week climbs steadily from 70% at age 3-4 to 100% by age 13-15.

In Brown's survey (1976) of the uses to which children put TV he found that the average 9 year old in Leeds talks about TV about 10 times as much as he/she talks about his/her peers. When a child feels sad he/she is 30 times as likely to turn on the box as to pick up a book. Whatever else one says about television it presents a rich and varied reflection of the world at various different levels. It also acts as a catalyst for interpersonal communication.

How can television be made accessible to deaf children? In the first place, of course, auditory information must somehow be converted to visual information. We start from the practical position of being able to add text to a TV picture. Given the knowledge that deaf children's English reading skills are generally depressed what guidelines are available for presenting English at an appropriate level?

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4. Published Guidelines for Modifying English for Deaf Children

Bench and Bamford (1979) gave hearing-impaired children pictures to describe and in this way elicited samples of natural language from 263 British children aged 8-15 years with varying degrees of hearing loss. The results of these controlled elicitation experiments are presented in the form of vocabulary lists and tabulated observations of the syntactic structures used by the children. These are of great interest in themselves. However, they are necessarily limited by the communicative situation used for data collection, i.e. expressive language related to a particular set of pictures. They are likely to be an underestimate of the children's receptive linguistic capabilities.

Silverman-Dresner and Guilfoyle's (1972) vocabulary lists offer a better indication of 8-17 year old, albeit American, deaf children's level of understanding of English words, in terms of their ability to select synonymous phrases for vocabulary items. However, some of these phrases appear to be rather circumlocutory, e.g. "day" = "the time between sunrise and sunset"; and rely on rather more than simple semantic knowledge. Furthermore, there is unfortunately very little correspondence between these lists and those of Bench and Bamford. This will be partly due to the different testing methods but it may also reflect substantial Anglo-American linguistic and educational differences.

The syntactic research of Quigley et al. has been usefully collated in the form of multilevel TV subtitling guidelines by WGBH-TV, Boston (Shulman and Decker, 1980). Again the research was conducted with American children and the guidelines (for subtitling at three different graded language levels) are rather difficult to follow without a solid grounding in modern grammatical theory. However, they offer a comprehensive picture of the syntactic abilities of deaf children as tested by Quigley et al. To date the strongest critique of these guidelines comes from Braverman (1981) who tested children's comprehension of subtitles presented at the three different levels. She found no consistent differences between children's performance at the three levels. This may be partly due to the fact that all the comprehension questions were presented at the lowest of the three levels so that the children could at least understand the questions. Thus it was not possible to ask any very challenging questions. It is significant to note that children with a measured reading ability of above grade 3 (equivalent to a reading age of 9-10) were able to cope well with all three levels. Thus these guidelines offer a good baseline for subtitlers.

A more dynamic model of linguistic awareness comes from the classroom itself. Teachers of the deaf spend many hours communicating directly with deaf children and learn a great deal about how to interpret and re-interpret English at levels suited to the children they teach. Ways of capitalizing on this knowledge-from-experience are discussed later (Section 5.2.3). Similarly, many prelingually deaf adults have valuable intuitions about the linguistic capabilities of deaf children, not least by virtue of having been deaf children. Some of this knowledge is already being applied in the production of the Breakthrough Trust's Home Library of adapted story books. Revised texts are pasted into the books on top of the original story texts. Deaf adults are closely involved in these productions (Wheeler, 1982). Some examples of the drastic levels of editing typical of the

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Home Library are shown in Appendix I. A thorough linguistic analysis of these revised texts may be revealing. It is also important to get some idea of the effectiveness of the texts in use. However, apart from the WGBH-TV work none of these sources relates directly to the presentation of English text in conjunction with television programmes.

The remainder of this report will therefore concentrate on experimental work carried out by the research team at Southampton University with the intention of learning more about the appreciation of television subtitles by English deaf school children.

5. Summary of Experimental Research carried out in Schools for the Deaf

5.1 Pilot studies

Two pilot studies were conducted in schools for the deaf in the South of England. A range of programmes was shown with subtitles at various language levels and presentation speeds. Children were asked to answer comprehension questions and to give their subjective reactions to the quality of the subtitles. Detailed results of these studies are available elsewhere (Baker, 1982). In summary, it was found that almost all secondary age children at these schools felt able to cope with subtitle presentation speeds of around 60 words per minute.
The children expressed almost universally high levels of enjoyment of the programmes. However, their appreciation of the programmes, apparent from observation during the viewing sessions and from their own comments and questions after the sessions, is somewhat belied by their performance on the written comprehension tests. All the tests used required children to answer questions in their own words, and so it is impossible to tell whether their apparently low level of comprehension is primarily a reflection of their expressive language difficulties. In the succeeding experiments it was therefore decided to use a forced choice response format.

5.2 The main experiments

A series of formal experiments was carried out to evaluate deaf children's appreciation of subtitled television programmes. These experiments are described in detail in Appendix II.
The issues explored were:-

i). the optimum presentation rate for subtitles,
and ii). the measurement of programme content comprehension, using multiple-choice questionnaires.

5.2.1 Subtitle presentation rate

Secondary age deaf schoolchildren were shown a range of programmes with subtitles presented at rates varying between 30 and 120 words per minute. Children classified the subtitles as either "too slow", "too fast", or "just right". A presentation rate of 60-90 words per minute was found to be acceptable for the vast majority of children. None of the children found a 60wpm rate "too fast". A significant minority found 90wpm too fast, and virtually all children in these tests found 120wpm unacceptably fast (120wpm is the accepted maximum rate for adult television subtitling).

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5.2.2 Comprehension tests

Two different experimental designs were used.In the first design a criterion words-per-minute rate (60wpm) was used to produce an edited version of a nature documentary, which had an original soundtrack speech rate of around 120wpm. To achieve this level of editing considerable simplification of the original script was necessary. Subsequent objective linguistic measurements of vocabulary and syntax confirmed that simplification had actually taken place. The original version of the soundtrack was then modified as little as possible to produce a "quasi-verbatim"

version at a regular 120 wpm. Childrens' comprehension of the edited and quasi-verbatim versions of the subtitles was compared, with three groups of deaf subjects from the City Lit. Centre for the Deaf, London, and Nutfield Priory School, Redhill. The comparison was done by showing all the children both versions of the programme, spread over two viewing sessions. This was done in such a way that each viewing session contained 50% edited and 50% quasi-verbatim subtitles in a counterbalanced design. The differential amount of information gained between the two viewings was then taken as a measure of the relative effectiveness of the two subtitled versions. Comprehension of the edited version was found to be superior for two out of the three groups of children. The third group performed so badly on both versions that a comparison was scarcely meaningful. It was concluded that language level did affect performance on comprehension tests, and that script reduction to a criterion text presentation rate is an effective means of achieving a more manageable language level.

In the second experimental set-up the same subtitles, both quasi-verbatim and edited subtitles, were used, but this time presentation rate was held constant at 60wpm. Furthermore a pre-test of knowledge about the subject in hand was given before the TV programme was viewed. This was done in order to achieve an absolute measure of information gained from viewing the programme. Five groups of children from the Royal School for the Deaf, Margate, were tested. The children were seen to gain significantly from viewing both edited and quasi-verbatim subtitles. Comparing the two subtitled versions directly there was found to be a slight advantage for the edited subtitles, but this did not hold up robustly under statistical tests. The simple conclusion was that subtitle presentation rate was a better predictor of comprehension than language level per se.

An attempt was made to look more closely at the linguistic structure of the subtitles used in both comprehension experiments. Several objective linguistic measures, including standard readability formulae, syntactic complexity formulae, and vocabulary frequency counts, were applied to all the subtitle texts, both original and edited, which were associated with the comprehension questions. These measures were then correlated with comprehension test scores (see Appendix II) in the two main experiments. No reliable correlations were found; indicating that interactive semantic effects of source texts, test questions and answers had a greater effect on performance than any simple structural measures.*

***Footnote:**

A more direct test of the influence of linguistic structure on subtitle reading was carried out in an earlier experiment with adults (see Appendix III). This experiment involved allowing subjects to read subtitles at their own preferred reading rates in a self-paced reading task. No reliable correlations could be found between the subjects' reading speeds and any of the structural measures applied to the subtitle texts. It may of course be the case that we have not yet selected any appropriate structural measures, but in the meantime we must defer to semantics.

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5.2.3 The art of subtitle editing

We have been unable to establish any mechanically applicable rules for subtitle editing. We may, however, be able to draw generalisations from the experience of people who regularly work with deaf children.

Many of the teachers of the deaf who helped in organising our experiments have made observations to the effect that they would have produced subtitles somewhat differently from those produced by the experimenter; indeed they feel that they themselves are in an ideal position to tailor the language level of subtitles to suit the needs and abilities of the children they teach. It is undoubtedly true that experienced teachers spend a great deal of time adjusting their own language and the language of educational materials to fit the communication skills of deaf children.

As an initial experiment a teacher was asked to produce her own set of edited subtitles for the same nature documentary that had been used in the other experiments. A linguistic analysis of her work was undertaken. The teacher's editing was analysed according to two basic overall strategies, i.e. removal of items and substitution of items. Within these strategies the vast majority (95%) of edits could be placed into readily definable linguistic categories. The complete analysis is given in Appendidix IV. Some general conclusions will be drawn here.

It is worth noting that some of the editing strategies listed in Appendix IV (e.g. removal of prepositional phrases, adverbial clauses and relative clauses) are particularly effective in reducing the number of words.

Another feature of the data is the extent to which certain linguistic features are exhaustively edited out. Thus for example although 4 adverbial clauses are removed, 7 others are retained in the script. Interestingly the retained clauses are mainly "because" clauses. This teacher may consider that "because" clauses are easier to cope with than other adverbial clauses. Similarly although 22 prepositional phrases are deleted, 34 others are retained. Again, a generalization can be made about the 34 retentions, in that they predominantly function as Verbal Complements (.e.g. "They paid for dead hedgehogs") rather than adverbial adjuncts (e.g. "They paid for dead hedgehogs in the seventeenth century). The former are far more closely integrated into the verb phrase and accordingly less dispensible than the latter. As a final example all the occurrences of a thematizing relative clause (Substitution Class iii)) are altered. This may well be considered a particularly difficult construction for deaf children. On the other hand, this structure is also particularly verbose and fair game for editing. Further research is necessary in order to distinguish linguistic structures which are inherently difficult for deaf children to comprehend from those which are simply easy to edit for the sake of reading time.

It is significant that simple deletions account for three quarters of the total reduction in words resulting from the teacher's editing. Given this observation it is worth considering the extent to which such deletions might be carried out automatically by the development of linguistically sensitive software. For example, an algorithm which recognises with minimum ambiguity all subordinating conjunctions (a closed set of items such as "when", "because", "although") with their associated punctuation (commas at the end of a subordinate clause) could automatically remove subordinate adverbial clauses

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from the script. Dealing with prepositional phrases would be more difficult. Prepositions (again a fairly small closed set of words) could be readily picked out. However, the limits of a prepositional phrase are less easy to establish. For example in "after three days coarser prickles grow through" it is difficult to determine which of the words ("three", "days", "coarser" or "prickles") closes the phrase, without a complete syntactic analysis. Optimized rules based on probability statistics might be established but these would inevitably be prone to error. In this particular instance the existence of a word ending in "s" halfway through the string is a probable indicator of a plural noun (rather than, say, an adjective) and the software might correctly identify "days" as the end of the prepositional phrase. However, a rule based on this generalization would analyse "After the tennis / match four balls were found" incorrectly, as indicated by the slash mark. More importantly, such syntactic algorithms would not be capable of making semantic or pragmatic judgements about whether the prepositional phrase in question is dispensible in the context of the television commentary. These judgements are made most efficiently by a human being who understands the TV programme.

Nevertheless, the kind of limited syntactic analysis which is hinted at here, and which has already been incorporated into linguistically sensitive subtitle formatting algorithms (see Lambourne, 1983) could be used to alert a human editor to potentially editable pieces of text. This possibility should be explored further. To give two further examples, let us consider the deletion of adjectives and the identification of infrequent vocabulary items.

In the first instance we might envisage software which unambiguously identifies all the closed set grammatical function words of English (conjunctions, prepositions, articles, possessive pronouns, etc.). Given a string of words, for example:

"The babies make a continuous piping sound, like a nest of young birds."

the underlined words and the punctuation could be fairly unambiguously identified. It could then be correctly hypothesised that between the first "a" and "like" all the items except the last are likely to be adjectives.

A minimal method of dealing with vocabulary frequency would be to incorporate a dictionary containing only the most frequent words in English. Thus, for example, the 50 most frequently occurring words typically account for 60% of speech (Denes, 1963). By increasing dictionary size to the 1000 most common words we could account for approximately 75% of spoken English. Having selected an appropriate dictionary size it is fairly straightforward to use search algorithms to identify words which are not common. The editor would refer these to his/her thesaurus in order to look for a more common synonym.

In conclusion, good use could be made of the linguistic expertise of teachers of the deaf to develop general software-based aids for the subtitle editor. It is an open question whether these would be more efficient than the use of a real live teacher, a paper script and a red biro.

Two more reservations must be made about this preliminary exercise in subtitle editing. Firstly, the hedgehog documentary is by no means representative of the kind of language used in TV programmes. More research with a wider range of programmes would be necessary before reliable generalizations about editing

strategies could be made. Secondly, it is necessary to establish the extent to which the editing done here has actually made the programme more accessible to deaf children. Two cases must be considered; on the one hand the case of the children for whom this particular editing was done, and on the other hand, the case of other comparable groups of deaf children.

In a small-scale study conducted at Heathlands School for the Deaf, St Albans, the teacher-edited subtitles were compared with the quasi-verbatim subtitles of the programme. The same comprehension test and experimental design was used as had been used at the City Lit. and Nutfield Priory, but subtitle presentation rate was held constant at 60wpm, as at Margate. It should also be noted that the teacher who had edited the subtitles had not worked at Heathlands School.
Thus all the children saw both a teacher-edited and a quasi-verbatim version of the subtitles. On those questions which the children saw first in the teacher-edited version and second in the quasi-verbatim version, there was no improvement at all in comprehension from the first to the second viewing. On those subtitles which the children saw first in the quasi-verbatim version and second in the teacher-edited version there was a 25% improvement in comprehension between the two viewings (a significant improvement at the 5 per cent level on a sign test), thus confirming the effectiveness of the teacher's work, even with a group of children with whom she was not familiar. Further studies are required to establish the generalizability of teachers' editing strategies.

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6. Conclusions, Recommendations for Broadcasters, and Key Issues for the Future

6.1 Conclusions

The experiments described above have merely scratched the surface of some of the linguistic issues involved in the adaptation of television programmes for the benefit of deaf children. It has been shown that subtitles can and do make programme content accessible to deaf children, provided they are presented at a manageable reading rate. Reduction to a suitable reading rate is an efficient and effective strategy for simplifying the language level.
It has also been shown that teachers of the deaf are in a priveleged position to carry out suitable subtitle editing. Many teachers would maintain that subtitling should be carried out on a local basis, so that individual teachers can have direct control over language level. A project designed to meet the demand for school subtitling facilities is currently in progress at the University of Southampton. The aims of this project are outlined below (Section 6.3), since they have general relevance to the work carried out to date. In the meantime, however, what useful conclusions can be drawn for broadcasters wishing to subtitle programmes for deaf children ?

6.2 Guidelines for subtitling television programmes for deaf children

Three kinds of generalizations may be useful:-

a) Generalizations about subtitling

The most important generalization to be derived from the experiments reported above concerns subtitle presentation rate. A subtitling rate of 60 words per minute should be acceptable for most middle and secondary school age children. Television scripts should therefore be edited down to allow one second of display time for each word in a subtitle. Secondly, subtitles should make sense linguistically, both in their own terms, i.e. they should be in good coherent English, and in relation to the programme as a whole, i.e. the verbal and pictorial context. Fulfilling all these requirements will result in considerable simplification of the English used in the subtitles. Other general recommendations for subtitle display are to be found in Baker et al., 1982.

b) Generalizations about language

Simple language is almost invariably more parsimonious than complex language. This applies both to vocabulary - more frequent words are shorter, and to syntax - more straightforward syntax uses fewer words.
Writing simple language is a matter of experience. However, useful guidelines are available from, for example, the "Plain English Compaign" (Cutts and Maher, 1980). The handiest reference book for word frequency is Thorndike and Lorge (1944). This should be used in conjunction with any good thesaurus or synonym finder, (e.g. Rodale, 1979). In general, the experienced subtitler's own intuition is as good a guide as anything to word frequency. The main problem area will be infrequent words that

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are essential to a particular programme - for example the word "hedgehog" does not occur at all in Kucera and Francis' million word sample, and only 3 times in Thorndike and Lorge's. Such rare but essential words can be backed up by proper exploitation of Teletext facilities (see next section).

c) Generalizations about the capabilities of deaf children

Apart from the need for adequate reading time we have been unable to identify with any consistency those linguistic features which make subtitles particularly difficult or particularly easy for deaf children to cope with. This should not surprise us. A comparable situation would be for the researchers to attempt to establish, through a couple of experimental sessions, how much French is known by the reader of this report (or indeed how much French is generally known by ORACLE subtitlers). Ability to understand French will almost certainly exceed ability to generate French. Any comprehension test will necessarily be selective. Your evening class French tutor will probably be able to give me a good idea of your competence; and would almost certainly be able to communicate quite a lot to you in French commensurate with your level of competence. If I wish to communicate with you in French I will choose the simplest language as a starting point. Ideally I should spend an extensive period getting to know your individual strengths and weaknesses. With the technical facilities of teletext at my disposal I would wish to stretch your skills, introducing new words, with simple definitions on teletext support pages, which you could refer to before and after our communication. If you had never experienced 'living' French by spending time in France I would be particularly keen to introduce colloquial expressions, once again with adequate back-up on teletext support pages, and with great care. Roughly the same considerations apply to subtitling for deaf children. Guidelines such as those of Shulman and Decker (1980) should be thoroughly digested, but flexibly applied. If introducing material which is likely to be unfamiliar, it should only be done when meaning is clear from the context or when words are defined in advance; and additional reading time should be allowed. New material should be embedded in simple familiar material. The television picture itself may help to establish new meanings. Assuming a position as an arbiter of language input is difficult and uncomfortable. However it is important that such a position is taken. Otherwise "access" becomes meaningless. The wider the range of material shown the better, and broadcast television could play a vital role in providing exposure to many aspects of English in an inherently appealing medium. Ideally teachers of the deaf and prelingually deaf adults should be involved in the preparation of subtitled programmes since their intuitions will be invaluable.

6.3 Key issues for future research

It is necessary at this point to make a distinction, glossed over elsewhere in this report, between two separable though interrelated functions for television subtitling in an educational context. As with the earlier research on subtitling for hearing-impaired adults, it has been assumed in this report that the primary purpose of adding subtitles to TV programmes is simply to provide access to programme content. This is a broadcaster's point of view. From an educator's point of view,

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however, the subtitling process may be seen to have an inherent educational function of its own. Most obviously subtitling, in contrast to conventional reading materials, offers a means of presenting English language to deaf children in a dynamic and relatively naturalistic context.

Wide consultations with teachers of the deaf suggest, however, that it is certainly not the case that the linguistic interpretation effective with one group of deaf children will be suitable for other groups. The style of communication between a particular teacher and a particular class of children appears to be intimate and virtually unique.

To take optimum advantage of the process of subtitling, teachers require the facility to specify the language level themselves, so that children can be exposed to new syntax and vocabulary in a controlled fashion. To this end the Mountbatten Memorial Trust is supporting a research project at the University to investigate the production of low-cost video subtitling equipment for the educational market.

The objectives of the project are as follows:

i). the development of a low-cost subtitling system, taking advantage of technical hardware already widely available in the educational environment; for example VHS videorecorders and BBC microcomputers. A survey of the technical facilities of all the primary and secondary educational institutions catering for deaf children in the UK has recently been completed (see Baker, in preparation).

ii). the provision of special-purpose software which will enable teachers without specialist technical knowledge to produce subtitles easily and efficiently in the limited time available to them.

iii). an evaluation of teachers' use of the prototype equipment with a view to enhancing the system, providing additional facilities where required, and extracting linguistic generalizations from teachers' subtitling strategies, so that educational subtitling guidelines can be made available.

iv). an evaluation of the effectiveness of 'do-it-yourself' subtitling in the classroom, both in terms of pupil motivation and of language development. This will require observation of the system in use over a period of time.

v). an examination of the potential for operating the preparation equipment with deaf children themselves. A robust and operationally self-explanatory subtitling system could provide deaf children with a powerful and flexible tool for creative language work - adding their own words to moving pictures.

It is hoped that the results of this research will be of value to broadcasters and educational technologists as well as to teachers wishing to exploit the full potential of TV subtitling as an educational resource.

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APPENDIX I

Sample of language simplification carried out by the Breakthrough Trust Home Library.

APPENDIX 1

THE GIANT ALEXANDER

Original text (199 words)

The Giant Alexander was on his way to America by aircraft carrier. The last few days had been very exciting. First his great friend, Timmy Dew, who was nine years old and lived next door, had brought him a telegram. It was from the President. It said, "Need your help. Can you come ?" Alexander cabled back "Of course. Finding ship."
As he was sixty feet tall he couldn't travel on an ordinary ship, so his old friend Coastguard Pennock had rung up the First Lord of the Admiralty in London and told him the problem.
"Go to Plymouth", his Lordship had said, "and meet me at the docks tomorrow at noon".
Alexander had packed a few clothes into a kit bag and said goodbye to Timmy. He promised to send him lots of picture postcards from America.
Now he had been on the aircraft carrier for two days. He had marvellous food because there were four special cooks to cook for him. He loved being at sea. At night-time he curled up like a cat and a lift took him down to where the planes were usually kept so that he could sleep safe and sound.

Breakthrough Trust version (79 words)

A telegram came for the Giant Alexander from the President of the USA.

He read: "We need your help. Will you come to America ?"

Alexander sent a telegram to the President: "I am coming".

Alexander was very, very tall.

He went to America on an aircraft carrier.

Alexander liked the aircraft carrier.

He had lots of lovely food.

Every night he went down in the aircraft lift to sleep.

He thought, "Why does the President want me in America ?"

APPENDIX II

Details of experiments carried out at the City Lit., Nutfield Priory School for the Deaf, and the Royal School for the Deaf, Margate.

APPENDIX II

AII.1 Study 1: Visits to the City Lit. and to Nutfield Priory Secondary School for the Deaf

AII.1.1 Preliminary experiment at the City Lit - Subtitle Presentation Rates

Prior to the main study a group of ten prelingually deaf school leavers attending courses at the City Lit., London, took part in an experiment to determine what their preferred subtitle presentation rate would be. A Westward TV drama documentatary for children, "Maggie's Moor", was subtitled with sections of subtitles presented at 4 different rates; 30, 60, 90 and 120 words per minute. The group was simply asked to evaluate each presentation rate as either "too slow", "just right", or "too fast". The results are given in Table 1.

Table 1

Subtitle presentation rate	Subjective Evaluation (n=10)		
	Too slow	Just right	Too fast
30 wpm	8	2	0
60 wpm	4	6	0
90 wpm	1	7	2
120 wpm	0	0	10

It is clear from this table that a presentation rate somewhere between 60 and 90 words per minute will be ideal. At 60 wpm we can be confident that the presentation is not too fast. A rate of 120 wpm is unanimously considered too fast for comfortable reading.

A recent replication with with 11-12 year old prelingually deaf children at Heathlands School, St Albans, and a different TV programme, confirms these results almost exactly.

AII.1.2 Materials and Method of the Main experiment

A "Survival" documentary on the life and habits of the hedgehog was subtitled at two different levels; a quasi-verbatim transcript of the original soundtrack at 120 words per minute, and an edited version at 60 words per minute. The edited subtitles were "simplified" according to the general subtitling guidelines in Baker (1981) and the subtitler's own intuitions about straightforward English:-

Quasi-verbatim script	There are authentic records of hedgehogs killing and eating adders.
Edited version	Hedgehogs sometimes kill and eat adders.

A ten minute sequence from the programme was then taken and divided into two sections of five minutes each, resulting in two video tape recordings, one tape with 60 wpm subtitles in the first half and 120 wpm in the second half, and a second tape with 120 wpm subtitles in the first half and 60 wpm subtitles in the second. A multiple choice comprehension test was also designed in which six of the twelve questions could be answered from subtitles presented in the first half of either tape and the other six could be answered from the second half of either tape. The questionnaire is given at the end of this Appendix.

The City Lit. group and two groups of secondary age children from Nutfield Priory Secondary School (one group aged 11-13 and the other aged 14-16) took part in the experiment. The experiment took the form of two viewing sessions. All groups started with the version of the programme which had subtitles in the first half at 60 wpm and the second half at 120 wpm. This was done since it was considered unwise to start the session with a section of subtitles which may have been way beyond the capabilities of the children. The comprehension test was administered after the first viewing. The second version of the programme was then shown, with the first half at 120 wpm and the second half at 60 wpm. The comprehension test was then administered a second time.

AII.1.3 Analysis of Results

Tables 2-4 show the percentage of questions answered correctly in each half of the programme for both viewings and for all three groups of viewers.

Table 2

Percent correct answers on multiple choice test
City Lit.(10 subjects)

	First viewing	Second viewing	Improvement from first to second viewing
1st half of programme	47	38	-9
2nd half of programme	15	38	+23

Table 3

Nutfield Priory Younger Group (26 subjects)

1st half of programme	56	65	+9
2nd half of programme	56	69	+13

Table 4

Nutfield Priory Older Group (22 subjects)

1st half of programme	38	62	+24
2nd half of programme	24	47	+23

Since each multiple choice question offered four possible answers a chance level score would be around 25%. The prediction from the experiment is that, if the language level at 60 wpm is really easier to comprehend than at 120 wpm, then the improvements for the second half of the programme should be

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greater than for the first half of the programme. This is shown most clearly in the City Lit. (henceforth CL) results where the 120 wpm version of the 1st half of the programme has confused the subjects so much that they actually scored less on the second viewing than on the first (60 wpm) viewing. On the second half of the programme a worse than chance score on the first viewing (120 wpm) is significantly improved by a second viewing at 60 wpm ($p < 0.05$, 1 tailed t-test). The same differential effect between the two programme halves is seen again with the Younger Group of Nutfield Priory children (henceforth NPY). Here, however, the improvement from one viewing to the other is statistically significant for both programme halves ($p < 0.025$, $p < 0.01$ respectively), but the difference between the two improvement scores is not significant. With the Older Group of Nutfield Priory children (henceforth NPO) the effect does not show at all. Here the extent of improvement for both halves of the programme is virtually identical. However, two things are noteworthy. Firstly, the score on the second half during the First Viewing is around chance, and this is improved on the Second Viewing to a score comparable with the other two groups of children. Secondly, it is worth noting that NPO's scores are substantially lower than NPY's throughout. This could be either because the older group were less interested in the programme or because they were less able than the younger group. The former alternative is contradicted by NPO's answers to an additional question on the questionnaire, asking whether they "enjoyed" the programme. All the older children answered "yes" to this question, whereas only sixteen of the twenty six younger children answered "yes" (four answered "No", four answered "OK" and two gave no response). The second hypothesis, that at least some of the older children were less able than the younger group, is confirmed if NPO's data are analysed in terms of high and low scorers on the questionnaire. This reanalysis is shown in Table 5.

Table 5

High and Low Scorers in the Older Nutfield Priory Group
Percentage correct responses on comprehension questionnaire

	First viewing	Second viewing	Improvement
1st half			
High scorers	65	88	23
Low scorers	11	36	25
2nd half			
High scorers	42	83	41
Low scorers	6	11	5

From Table 5 it is clear that the High Scorers show the differential improvement effect for the two programme halves. Both improvement scores are statistically significant ($p < 0.01$). The difference between the two High Scorers' improvement scores is not significant, though the trend is in the predicted direction. Low scorers on the other hand do not show the effect at all; indeed their scores are so low overall that they may almost be discounted as chance behaviour. Finally it is worth noting that the CL and NPO groups found the questions relating to the second half of the programme more difficult than those relating to the 1st half of the programme. The questions will

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be looked at again below.

In general these results tell us two things. Firstly that the children's performance on the questionnaires is influenced by the language level of the subtitles. Secondly we may conclude that the strategy of editing the subtitles to a criterion lower words per minute rate has effectively made the language level more accessible to the children.

AII.1.4 Correlations between questionnaire performance and linguistic characteristics of subtitles

It is possible to look more closely at the language used in the subtitles in order to see whether specific linguistic factors have any effect on questionnaire performance. This was done by taking the particular subtitle texts (the source texts) to which the comprehension questions relate and analysing each text according to various linguistic measures.

The measures taken were as follows:-

1. Average word frequency of words in subtitles
   a) Thorndike Lorge List (1944)
   b) Kucera & Francis word frequency list (1967)
2. Average word length i.e n characters/n words.
3. Average sentence length, i.e. n words/n sentences.
4. Absolute number of words in source texts, i.e. a source text may consist of more than one sentence.
5. Presentation rate in characters, i.e. characters/sec (a more sensitive measure than the 60 wpm/120 wpm dichotomy.)
6. Proportion of words in comprehension question which also occur in source text, i.e. a negative measure of the amount of inference necessary to answer the question.
7. Two measures of syntactic complexity.
   a) Ratio of conjunctions to pronouns in source texts (a high ratio is considered to reflect a high level of complexity (Bormuth, 1968)).
   b) Botel syntactic complexity index. This measure counts occurrences of a set of specified structures; e.g. indirect objects, prepositional phrases, infinitive verbs, etc. (see Botel and Granowsky, 1972)
8. Six standard readability formulae.
   These were available for automatic analysis on a software package developed by an undergraduate at the University (H.Franklin). They comprised the following formulae; FOG, SMOG, Forcast, Powers-Sumner-Kearl, Flesch, Dale; all the formulae are derived from various calculations of word length and sentence length, and are related to widely accepted standard reading ages, (Harrison, 1980).

The two source texts below and the scores in Table 6 exemplify the method used.

Quasi-verbatim version

"The babies make a continuous piping sound like a nest of young birds".

Edited version

"They make sounds like baby birds".

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Table 6
Linguistic measures on a related pair of subtitle source texts (i.e.the example given above).

		Quasi-verbatim	Edited
Average word frequency	a)	82.6	100.0
	b)	11974	9979
Average word length		4.3	4.5
Average sentence length		13	6
n words		13	6
characters/sec		8.0	4.5
Proportion of question words in source		3/7	3/7
Ratio Pronouns:Conjunctions		0:0	1:0
Botel complexity score		5	2
FOG		12.6	7.4
SMOG		13.5	8.0
Forcast		12.3	10.0
Powers-Sumner-Kearl		9.8	8.6
Flesch		11.7	9.8
Dale		13.6	13.0

Using these measures it was possible to establish that all the edited versions were indeed simpler than the quasi-verbatim versions on nearly all counts.
At this point it should be stated that one of the intentions of the linguistic analysis was to establish which, if any, of the measures could be profitably incorporated into computer software for automatic analysis of source texts. This might aid the subtitler during the editing task. Some of the measures are purely mechanical (e.g. word length, sentence length, and most of the readability formulae) and could be automated with ease. Others, like word frequency and Botel's syntactic complexity score, may require an exhaustive dictionary on the one hand, and detailed syntactic analysis algorithms on the other. Cruder measures could be considered such as the proportion of highly frequent words (of which there are a fairly manageable number of different items), or a rudimentary syntactic analysis through the identification of closed sets of syntactic words (such as the pronoun:conjunction ratio).

A number of problematical features can be seen in the examples given in Table 6. Firstly, there are enormous discrepancies in the word frequency measures. In the Thorndike-Lorge lists, words that occur more than 50 times per million

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words and less than 100 times are given a score of A; words occurring more than 100 times receive a score of AA. In the calculations for this experiment 50 has been substituted for A and 100 for AA. Thus the average scores are weighted against very high frequency words, giving more evenly distributed averages.The Kucera and Francis lists, by contrast, give a full listing of absolute frequencies in a million word sample so that a comparatively large number of extremely frequent words (e.g. "the", "a", "of") in the quasi-verbatim source give an inflated average compared with the edited version.

Also noticeable is the wide range of scores offered by the readability formulae. It should be stressed that all these formulae are standardized on texts which are at least 100 words in length. We should therefore not be surprised by discrepancies when dealing with very short texts. Nevertheless it was decided to take the measures at face value in order to attempt to fulfil the subtitle editor's requirement of pinpointing difficulties in necessarily small chunks of text.

A correlation analysis was undertaken of the linguistic measures on each source text and the numbers of correct responses to the related comprehension questions by the three groups of subjects.

Out of this analysis only one linguistic variable correlated significantly with any of the groups' test scores. The correlation between the absolute number of words in the source text and the performance of the Older Nutfield Prior group was minus 0.47 n=24 (24 source texts and 24 questions) $p<0.05$, i.e. the more words contained in a source text the less likely will be a correct answer. This 'Verbosity' effect does not relate to sentence length but to the absolute number of words in the source. The effect does not hold for either of the other groups and may be a chance correlation. *

As would be expected, all the standard readability formulae correlate positively and significantly with one another and with word length and sentence length. Furthermore, the questionnaire performances of the three groups of children correlate positively and significantly with one another.

A more sensitive score for the correlation analysis can be derived from a comparison of the paired source texts from the two different versions of the programme.

Thus if we take the source texts analysed in Table 6 we simply subtract the entries in the "Edited" column from those in the "Quasi-verbatim" column and correlate these "Difference" scores with the children's "Improvement" scores on the corresponding questions. Thus, for example, the Improvement scores on Question 3 ("What sound do baby hedgehogs make?") from First Viewing (120 wpm) to Second Viewing (60 wpm) for the groups CL, NPY and NPO are +4, +10, and +14 respectively.

* **Footnote**: All the correlation coefficients in this report should be treated with caution. When a matrix of correlations between a series of independent variables is calculated, probability theory states that an increasing number of "significant" correlations will occur by chance, as the matrix increases in size. For this reason large matrices are generally avoided. However, in this report we are using correlation analysis essentially as a heuristic device for identifying possible associations. For this reason, casting the net too wide is unlikely to be a problem.

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Once again we find very little of interest in the correlation analysis. The 'Verbosity' effect, correlating NPO's performance with absolute number of words in the source texts, is lost, confirming its probable spuriousness. However, there are a few more interesting correlations.

Word frequency (on the Kucera and Francis list) correlates positively with the performance of group CL ($+0.75$ $p < 0.01$). Thus, for example, a big drop in average word frequency from the 60 wpm to the 120 wpm version is associated with a big decrease in questionnaire performance. However the same correlation holds significantly in the opposite direction for the NPO group (-0.77 $p < 0.01$).

Word length and sentence length correlate negatively with NPY's performance (-0.74 and -0.68 respectively). Thus a big increase in word length or sentence length (which are themselves negatively correlated, see also Appendix III) is associated with a big decrease in questionnaire performance. However, these effects are not consistent for all three groups.

We may tentatively conclude that a human subtitle editor is a more effective predictor of language difficulty than any of the mechanical procedures employed so far. The human editor, however, is not 100% reliable. For two of the questions (questions 5 & 10) performance at the 60 wpm level is actually slightly worse than at 120 wpm. No immediate explanation for this is forthcoming. The linguistic analyses are unhelpful, since they concur with the human editor in these cases.

In general, one factor that may be complicating the results is the confounding of subtitle editing with presentation rate. A further experiment was therefore conducted.

AII.2 Study 2: Visit to Royal School for the Deaf, Margate

Once again, two versions of the "Survival" documentary were produced. This time, however, the quasi-verbatim and edited subtitles were randomly jumbled on a 50:50 basis in such a way that 2 new versions of the tape were created, each containing 50% edited subtitles interspersed with quasi-verbatim subtitles, and each version being, as it were, a mirror image of the other.

The original sequence of the subtitles was of course preserved. However, all the subtitles were presented at 60 wpm, so that the gross effect of presentation rate was eliminated. Three groups of children (with an age range 12-16 in each group) took part in the experiment; Groups 1 and 2 saw one version of the tape and Group 3 saw the other. A more extensive questionnaire containing twenty one multiple-choice questions was compiled, with roughly half the questions relating to edited subtitles and the other half to quasi-verbatim subtitles. Since the two versions of the programme were mirror images of each other, every question was therefore tested with both an edited and a quasi-verbatim source text. A subset of 9 of the more general questions about the life of the hedgehog (i.e. questions that could reasonably be assumed as general knowledge without exposure to the documentary) was selected as a pre-test, which was administered to each group of children before the main part of the experiment. By comparing results on the pre-test with the matching questions on the full questionnaire administered after the viewing session, it is possible to obtain a measure of how much each child gained from watching the programme. The pre-test and the full questionnaire are given at the end of this Appendix.

The comparison of pre-test and post-test results is shown in Tables 7 and 8.

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Table 7 % correct questionnaire responses for Groups 1 and 2, n=31 (version 1 of programme)

	Pre-test (9 questions)	Post-test (9 questions)
Edited source texts (5 questions)	26	48
Quasi-verbatim source texts (4 questions)	14	40

Table 8 % correct questionnaire responses for Group 3, n=15 (version 2 of programme)

	Pre-test (7 questions)	Post-test (7questions)
Edited source tests (3 questions) *	20	49
Quasi-verbatim source tests (4 questions) *	18	37

* For technical reasons the data related to two of the questions had to be excluded from Table 8.

It is immediately apparent that substantial gains are made in the post-test. On average, over all three groups, there is a 120% improvement between pre- and post-test. This is statistically significant on a sign test (n children = 46, minus 7 ties. N =7 $p < 0.01$). It is clear, then, that the children are gaining quite a lot from the programme.

It also appears that the children perform somewhat better with the edited subtitles. The fact that this also holds for the pre-test, i.e. before the children have seen any subtitles at all, is puzzling, since the particular questions selected in the "Edited" and "Quasi-verbatim" categories are reversed for the two groups.

Results for the complete set of twenty one questions are shown in Table 9.

Table 9 % correct responses of 3 groups of children on 21 questions corresponding to quasi-verbatim and edited source subtitles

	Quasi-verbatim	Edited
Group 1 (n=16)	33	38
Group 2 (n=15)	32 *	32
Group 3 (n=15)	46	64

* $p < 0.025$

Since Group 3's quasi-verbatim subtitles correspond to Group 1 and 2's edited subtitles, and vice versa, it is possible to compare scores directly, as indicated by the arrows in Table 9. Only one comparison reaches statistical significance on a Wilcoxon matched-pairs signed-ranks test, as indicated in Table 9. ($T=6$ $n=9$, one tail test $p < 0.025$). The validity of even this result must be questioned in view of Group 3's overall superior performance. It would appear from Table 9 that one set of questions (those relating to Group 1's and 2's quasi-verbatim subtitles and Group 3's edited subtitles) is inherently easier to answer than the other set. This simply highlights the difficulty of designing adequate comprehension tests. Nevertheless, overall, the edited subtitles do produce a slight, though statistically insignificant, improvement in performance.

It is interesting that the effects of editing are not so marked with the Margate children as with the children in Study 1. This may be due to the difference in the experimental design. For example, the interspersing of edited and quasi-verbatim subtitles may lead to an irregular reading strategy. More crucially, the effect of presentation rate has been eliminated in the Margate experiment so that the difference between the two language levels *per se* is focussed on. The simple conclusion to be drawn is that a manageable reading rate is more important than the actual language used in the subtitles. This is confirmed further by the Margate children's overall superiority in performance on the quasi-verbatim subtitles as compared with the children in Study 1 (cp. the performance of Group CL and ONP on First Viewing of the second half of the programme (Tables 2 and 4 above)).

A correlation analysis was conducted on the Margate children's questionnaire scores with all the linguistic variables investigated in Study 1. Once again the results are unreliable. The 'Verbosity' effect, i.e. the more words in the source text the less likely a correct answer, shows up again for Groups 1 and 2 (-0.84 $p < 0.01$) but not for Group 3. Group 3's scores are positively correlated with the proportion of words in the comprehension question which also occur in the source text ($+0.66$ $p < 0.05$) but this does not hold for Groups 1 and 2.

One finding from this analysis is enlightening. There were significant correlations between the performances of Groups 1 and 2, not only with each other, but also with Group 3 (Group 1 with Group 2 0.56 $p < 0.025$, Group 1 with Group 3 0.55 $p < 0.05$, Group 2 with Group 3 0.65 $p < 0.01$). In other words, comprehension questions on which Groups 1 and 2 score highly also gain high scores from Group 3 in spite of the fact that Groups 1 and 2 saw completely different source subtitles, indeed the subtitles were at different language levels. The conclusion to be drawn is that the relationships between specific questions and answers and their complex relationships with the prior knowledge and general ability of the children override the linguistic variables introduced in the subtitles.

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QUESTIONNAIRE USED AT THE CITY LIT AND NUTFIELD PRIORY SCHOOL FOR THE DEAF

Your name:

HEDGEHOGS

Please tick the right answer to each question. Each question has only one right answer.
Here are some examples with the right answers already ticked:-

Example A

Where do hedgehogs build their nests?

a). Beaches
b). Gardens
c). Golf courses ✓
d). Trees

Example B

What do fleas eat?

a). Dirt
b). Blood ✓
c). Hair
d). Ticks

Now do the rest of the questions

1. What do hedgehogs do when they are frightened?

a). Make loud noises
b). Dig a hole and hide
c). Stand still
d). Lie on their backs

2. How many babies do hedgehogs usually have?

a). 4
b). 2
c). 1
d). 8

3. What sounds do the baby hedgehogs make?

a). Like frogs
b). No sound
c). They bark like dogs
d). Like young birds

4. What are the hedgehog's spines made of?

a). Bone
b). Hair
c). Feathers
d). Wood

5. Why don't hedgehogs clean themselves?

a). They can't
b). They are too lazy
c). They don't get dirty
d). Dirt protects them from their enemies

6. What do hedgehogs eat?

a). Fleas
b). Grass
c). Slugs
d). Hens

7. What does the word "urchin" mean?
   a). A kind of tree
   b). Adder
   c). Hedgehog
   d). Flea

8. When do hedgehogs have their babies?
   a). July
   b). December
   c). June
   d). April

9. Why don't farmers like hedgehogs?
   a). They eat straw
   b). They frighten sheep
   c). They dig holes in the ground
   d). They eat eggs

10. How do hedgehogs pick up apples?
   a). In their teeth
   b). On their spines
   c). With their feet
   d). With their noses

11. What enemies do hedgehogs have?
   a). Traffic
   b). Horses
   c). Rabbits
   d). Cats

12. What does "self-anointing" mean?
   a). Hiding themselves
   b). Building a nest
   c). Getting rid of fleas
   d). Licking their spines

****

Did you enjoy the programme?

Any other comments?

PRE-TEST USED AT THE ROYAL SCHOOL FOR THE DEAF, MARGATE

YOUR NAME:

HOW OLD ARE YOU?:

Before we see the film about hedgehogs here are some questions. It will be easier to answer the questions after the film but perhaps you know some of the answers already. Try to answer them now.

1. What does "nocturnal" mean?
   a) Lives in trees
   b) Very dangerous
   c) Sleeps in the day time
   d) Looks like a newt
   e) I don't know

2. What does "onmivorous" mean?
   a) Eats anything
   b) Knows everything
   c) Likes flying
   d) Very dirty
   e) I don't know

3. What is "hibernation"?
   a) Building a nest
   b) Making films at night
   c) Sleeping through the winter
   d) High-powered driving
   e) I don't know

4. What do hedgehogs eat?
   a) Fleas
   b) Grass
   c) Slugs
   d) Hens
   e) I don't know

5. Why don't farmers like hedgehogs?
   a) They eat straw
   b) They frighten sheep
   c) They dig holes in the ground
   d) They eat eggs
   e) I don't know

6. What is the hedgehog's most dangerous enemy?

a) Horses
b) Cars
c) Foxes
d) Cats
e) I don't know

7. What do fleas eat?

a) Blood
b) Hair
c) Ticks
d) Dirt
e) I don't know

8. What does the word "urchin" mean?

a) A kind of tree
b) Adder
c) Hedgehog
d) Flea
e) I don't know

9. What is an "adder"?

a) A snake
b) A flea
c) A bird
d) A nest
e) I don't know

POST-TEST USED AT THE ROYAL SCHOOL FOR THE DEAF, MARGATE

YOUR NAME: .....

Please tick the right answer to each question. There is only one right answer.

1. What does "nocturnal" mean?
   a) Lives in trees
   b) Very dangerous
   c) Sleeps in the day time
   d) Looks like a newt
   e) I don't know

2. What does "omnivorous" mean?
   a) Eats anything
   b) Knows everything
   c) Likes flying
   d) Very dirty
   e) I don't know

3. What does a hedgehog do when it is frightened by a car's lights?
   a) Makes loud noises
   b) Digs a hole and hides
   c) Stands still
   d) Lies on its back
   e) I don't know

4. What do hedgehogs eat?
   a) Fleas
   b) Grass
   c) Slugs
   d) Hens
   e) I don't know

5. What are the hedgehog's spines made of?
   a) Bone
   b) Hair
   c) Pins
   d) Wood
   e) I don't know

6. What do fleas eat?
   a) Blood
   b) Hair
   c) Ticks
   d) Dirt
   e) I don't know

7. What does the word "urchin" mean?

a) A kind of tree
b) Adder
c) Hedgehog
d) Flea
e) I don't know

8. Why don't farmers like hedgehogs?

a) They eat straw
b) They frighten sheep
c) They dig holes in the ground
d) They eat eggs
e) I don't know

9. What is a Ringed Plover?

a) A kind of bird
b) A hedgehog
c) A bird's egg
d) A kind of tree
e) I don't know

10. What is the hedgehog's most dangerous enemy?

a) Horses
b) Cars
c) Foxes
d) Cats
e) I don't know

11. What other enemies does a hedgehog have?

a) Owls
b) Foxes
c) Horses
d) Lizards
e) I don't know

12. What does a hedgehog do if it meets an adder?

a) Rolls up in a ball
b) Usually runs away
c) Nothing
d) Sometimes eats it
e) I don't know

13. What is an "adder"?

a) A snake
b) A flea
c) A bird
d) A nest
e) I don't know

14. How many babies do hedgehogs usually have?
a) 4
b) 2
c) 1
d) 8
e) I don't know

15. When do hedgehogs have their babies?
a) July
b) December
c) June
d) April
e) I don't know

16. What sounds do baby hedgehogs make?
a) Like frogs
b) No sound
c) They bark like dogs
d) Like young birds
e) I don't know

17. What is "hibernation"?
a) Building a nest
b) Making films at night
c) Sleeping through the winter
d) High-powered driving
e) I don't know

18. What does "self-anointing" mean?
a) Hiding themselves
b) Building a nest
c) Getting rid of fleas
d) Licking their spines
e) I don't know

19. How do hedgehogs help in the garden?
a) They eat snails
b) They keep weeds down
c) They dig holes
d) They drink milk
e) I don't know.

20. Why don't hedgehogs clean themselves?
a) They can't
b) They're too lazy
c) They don't get dirty
d) Dirt protects them from their enemies
e) I don't know

21. What is the hedgehog's answer to most of life's problems?

a) Running away
b) Fighting
c) Jumping in the water
d) Rolling up in a ball
e) I don't know

APPENDIX III

Investigating the linguistic correlates of subtitle reading via reading speed measurements.

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Appendix III

Investigating the linguistic correlates of subtitle reading via reading speed measurements

In a separate series of experiments to be reported more fully elsewhere (Lambourne and Baker, in preparation.) a very different approach to tracking down important linguistic variables has been attempted. Ten hearing adult volunteers were asked to watch a version of the hedgehog documentary (without sound) and to cue in subtitles manually at their own preferred reading rate. The videotape had previously been edited to produce a relatively general sequence of scenes from the hedgehog's daily life, so that subjects would not be encouraged to attempt to relate specific subtitles to specific scenes on the screen. The primary aim of the experiment was to compare reading times for various different physical layouts of the subtitles (see Lambourne and Baker, in preparation.). However, a subset of 10 subtitle source texts which had already been analysed linguistically for the school experiments could then be subjected to a correlation analysis in terms of reading speed rather than comprehension test scores. Rather disappointingly only one subject's reading times showed a significant correlation with any of the linguistic variables. For this subject there was a negative correlation between speed of reading and the total number of words in a subtitle ($- 0.67$ $p < 0.05$) and an even stronger correlation with average sentence length ($- 0.80$ $p < 0.01$) i.e. longer sentences take longer to read. It is perhaps significant that this subject was a non-native English speaker and that the effect did not hold for any of the other subjects, who were all native English speakers. For the remaining subjects we must conclude that crude effects of sentence length (or any of the other linguistic variables) are overridden in determining reading speed by time taken to interpret the actual meaning of the texts (possibly compounded with subtitle layout effects). Of course only a very small amount of data has been analysed here.

In order to pursue the matter further a larger sample of the adult subtitle reading times was correlated with a subset of linguistic variables. Reading times of all the three-line subtitles ($n = 35$) read by the adult subjects were correlated with the number of words per subtitle, sentence length, number of characters per subtitle, average word length, and the FOG readability formula. None of the linguistic variables correlated significantly with any of the subjects' reading times. We must conclude again that semantic effects are paramount. All the linguistic variables were significantly intercorrelated. The only correlation here that requires comment is that between the number of words per subtitle and average word length (product-moment correlation -0.68 $p < 0.01$). Thus the more words there are in a subtitle the fewer long words it is likely to contain. This makes sense since longer structures will necessarily contain more grammatical "linking" words, which are typically short.

Finally, in connection with the adult reading time experiment, it is worth comparing the adults' responses to comprehension questions, administered after the self-paced reading task, with scores achieved by the children. This will give some indication of the relative amounts of information gained from reading the subtitles. Eight of the questions answered by the Margate children also occurred in a roughly comparable form on nine of the adult questionnaires. These were Questions 4, 5, 8, 10, 11, 14, 15 and 16 (see Margate

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questionnaire, Appendix II). The percentage correct responses for the adults and children on these questions are given in Table 10.

Table 10 Comparison of questionnaire scores for 9 hearing adults and 46 deaf children: % correct scores on 8 shared questions

	Children	Adults
Q4	24	78
Q5	37	33
Q8	57	100
Q10	74	78
Q11	2	89
Q14	54	100
Q15	67	67
Q16	24	67
TOTAL	42	77

Clearly, some questions are found more difficult than others even by the adult group; overall the adults score much higher than the children but in most cases the difference is not disturbingly high.

The rank order of difficulty of questions does not correlate significantly across the two groups (Spearman's rho 0.06 ns).

APPENDIX IV

The linguistics of subtitle editing - editing strategies used by an experienced teacher of the deaf.

Appendix IV

The linguistics of subtitle editing - an alternative approach. Editing strategies used by an experienced teacher of the deaf

Teachers of the deaf gain considerable experience in manipulating English to suit the needs and abilities of the classes they teach. To examine what teachers actually do may give us insights into appropriate subtitling levels. Ideally, this should be done by extensive but non-intrusive (a tall order) observation of teachers at work, so that useful generalizations can be made.

As a first attempt it was decided to ask a teacher to edit a subtitled TV programme. For ease of comparison the hedgehog documentary was used once again. A teacher with several years experience was given a print-out of the quasi-verbatim subtitles for the programme and asked to edit them down to a level suitable for the class she teaches.

A sample from the original subtitles and the corresponding edited versions is given below. The sample has been annotated to illustrate the linguistic analysis employed. The terminology is taken mainly from a comprehensive structural grammar of English (Quirk and Greenbaum, 1973).

Original	There[1] the young hedgehogs are born in June.
Edited	The young hedgehogs are born in June.
Original	When they are born[2], their spines are covered with thin skin.
Edited	Their spines are covered with thin skin.
Original	But[3] after three days coarser[4] prickles grow through, white at first but darker later.[5]
Edited	After three days harder prickles grow through.
Original	Their eyes are still closed.
Edited	Their eyes are still closed.
Original	Safe in their dark nest they don't need to see.
Edited	(Whole sentence deleted)[6].
Original	Their[7] first spines are fine[8], but very sharp.
Edited	The first spines are thin, but very sharp.
Original	There are usually four babies but sometimes as many as seven[9].
Edited	There are usually four babies, sometimes more.
Original	The babies make a continuous piping sound[10], like a nest of[11] young birds.
Edited	The babies whistle like young birds.

Notes

1. Deletion of adverb.
2. Deletion of adverbial clause (time).
3. Deletion of adverb. "But" is not strictly speaking an adverb, even in sentence initial position, but rather a sentence connecting conjunct. However, the distinction is subtle.
4. Vocabulary substitution.

5. Deletion of appositional phrase.

6. In many cases where whole sentences are deleted it is not clear whether this is because the information they contain is considered to be extraneous to the main line of the programme commentary, or whether the editor finds it difficult to come up with a simpler structure in place of a highly complex one without significantly increasing the sentence length (and hence reducing available reading time). In this case the latter is probably true.

7. Substitution of a possessive adjective by a simple determiner (article).

8. Vocabulary substitution.

9. Substitution of a comparative phrase by a simple comparative.

10. Substitution of a transitive verb construction by a simple intransitive verb.

11. Reduction of noun phrase.

To summarise the editing strategies used throughout the whole programme we will refer to Table 11. Table 11 is divided into two parts according to the two basic strategies used, i.e. deletion of items and substitution of items. It should be noted that substitution generally implies some deletion. However, items recorded under "Deletions" are restricted to the simple removal of single items or continuous strings of items.

The total effect of editing was to reduce 1398 words to 730, so that the edited version was 52% as long as the original. This gives an overall presentation rate for the edited version of about 60 wpm.

Table 11

Summary of subtitle editing carried out by a Teacher of the Deaf

a) Deletions

	Classification	No. of occurrences of deletion	No. of words accounted for by deletions
i)	Prepositional phrases, e.g. "The first on the scene .."	22	90
ii)	Complete sentences, e.g. "The closer one gets to them the more mysterious they seem"	16	178
iii)	Non-finite Clauses, e.g. "Surrounded by legends and superstitions ..." "She keeps well fed to nourish the babies	12	55
iv)	Adjectives, e.g. "large insects	10	10

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v)	Adverbial clauses, e.g. "As the camera team watched ..."	8	47
vi)	Co-ordinate clauses, e.g. ".. but he didn't stop"	8	58
vii)	Adverbs, e.g. "Eventually the couple wander off together"	7	7
viii)	Relative Clauses, e.g. "...which makes even a hungry predator drop it immediately"	4	33
ix)	Appositional structures, e.g. "..coarser prickles grow through white at first but darker later"	1	6
		Total	484 words deleted

= 72% of total word reduction

b) Substitutions

	Classification	Number of occurrences	Reduction in words per classification
i)	Straightforward (word for word) vocabulary substitution. e.g. "legends" > "stories"	51	0
ii)	Reduction of Noun Phrase e.g. "a nest of young birds" > "young birds"	5	15
iii)	Thematizing relative clause or infinitive clause > Main Clause e.g. "One animal that even hedgehogs won't eat is the toad" > "The hedgehog doesn't like eating toads"	5	33
	"The effect on the hedgehog is to make it wipe its tongue on its spines" > "The hedgehog licks its spines"		
iv)	Verb phrase > copula + adjective " ... come from long ago" > "are very old"	4	9

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v)	Transitive verb phrase > Intransitive verb phrase (+ Adverbial) e.g. "The warmer weather of spring brings them out ..." > "They wake up in spring"	3	18
vi)	Passive verb phrase > Active verb phrase e.g. "Around sunset hedgehogs are often seen on beaches" > "Hedgehogs often go on the beaches at sunset"	3	1
vii)	Subordinate Clause > Main Clause e.g. "...until their eyes are opened" > "Their eyes aren't open yet"	3	8
viii)	Reduction of Verb Phrase e.g. "They don't seem to bother" > "They don't bother"	2	5
ix)	Adjectival or nominal complement structure > transitive verb e.g. "Hedgehogs are useful to the gardener" > "Gardeners like hedgehogs"	2	6
	"But spines are no protection against the hedgehog's greatest enemy" > "Spines don't save hedgehogs from cars"		
x)	Possessive adjective > article e.g. "Their" > "the"	2	0
xi)	Main Clause > Adverb e.g. "We wondered if ..." > "Perhaps ..."	2	7
xii)	Nominal Complement > Main Clause e.g. "(We just have to accept)<u>that the stories are true</u>" > "(Perhaps)<u>the stories are true</u>"	2	0
xiii)	Anaphoric pronoun > Noun Phrase e.g. "it" > "the apple"	1	+1
xiv)	Adverbial Prepositional Phrase > Main Clause e.g. "This female lines up the grass <u>by turning round and round to comb the blades into place with her prickles</u>" >	1	10
	"The hedgehog's prickles comb the nest and make it smooth"		

xv)	Comparative Phrase > Simple Comparative Adverb e.g. "..sometimes as many as seven" > "..sometimes more"	1	3
xvi)	Coordinate Clause > Prepositional Phrase e.g. "builds a nest and rears the young ones" > "builds a nest for her babies"	1	2
xvii)	Sentence > Noun Phrase e.g. "A hedgehog under our apple tree was the subject of an experiment. While Liz watched ..." > "(Liz watched) a hedgehog under the apple tree".	1	6
xviii)	Complete rewrites e.g. "With 90 to the square inch they form excellent protection" > "They grow very close together"	6	43
	"A distant grunting and snuffling indicates that hedgehogs are about although they're invisible in the fading twilight" > "They can hear the hedgehogs but they can't see them".		
	Total		165 words deleted

= 23% of total word reduction

Together these two groups of editing strategies account for 95% of all the editing carried out. The remaining 5% consists of a ragbag of single word omissions such as articles ("the hedgehog" > "hedgehogs"), intensifiers ("very"), etc.

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